Remarks

Claims 1 to 37 are pending. Claims 1 and 12 are amended.

Claim Objections

Claim 12 was objected to because of the following informalities: Claim 12 recited the limitation "comprises one of an optical fiber and optical fiber" which is redundant. Claim 12 has been amended to eliminate this redundancy. Support for the amendment can be found at page 3, lines 17-20; and page 7, lines 19-23.

Claims 13-15 were objected to because they recite the limitation "the lens" which lacked antecedent basis. Claims 13-15 are dependent upon claim 12. Applicant respectfully submits that claim 12, as amended, provides the required antecedent basis. Applicant respectfully requests that the objections to the claims be withdrawn.

§ 102 Rejections

Claims 1-4, 7-10, 12, 28-30, 32, and 37 stand rejected under 35 USC § 102(e) as being anticipated by U.S. Patent Application Publication No. 2002/0097951 (Mortenson et al.).

The present invention relates to a package for optical micro-mechanical devices including one or more optical micro-mechanical devices on a first surface of a die (see page 2, lines 22-23), the first surface of the die including a die reference surface (see page 2, line 23). The package also includes a package frame comprising an aperture and a first surface, the first surface of the package frame including a package frame reference surface proximate the aperture, wherein the package frame reference surface is adapted to allow the die reference surface to be mounted to the package frame reference surface such that the optical micro-mechanical devices are located in the aperture (see page 2, lines 23-26; page 7, lines 2-7; and page 8, lines 14-16). One or more optical interconnect alignment mechanisms formed in the first surface of the package frame terminate adjacent to the aperture and are positioned relative to an optical interface reference plane (see page 2, lines 26-28; page 3, lines 7-9; page 7, lines 17-20; and Fig. 1). Distal ends of one or more optical interconnects, such as optical fibers, are located in the optical interconnect alignment mechanisms and are optically coupled with one or more of the optical micro-mechanical devices (see page 2, lines 20 – 31). See also amended claim 1.

Mortenson et al. teach an optical component switch package including a platform, a fiber support structure, a circuit chip, and plurality of fibers. The fiber support device is positioned on the platform and a circuit chip is disposed on the platform within an interior region of the fiber support structure (see paragraph [0004]). Referring to **Fig. 5**, in Mortenson et al., the micro-mechanical device **58** is located on the surface of a MEMS chip **50** (see paragraph [0021]).

In the present application, "die" refers to a substrate containing one or more optical micro-mechanical devices (see page 7, lines 7-9), and "die reference surface" refers to the top surface of a die upon which the optical micro-mechanical devices are constructed (see page 8, lines 23-24). Thus, Applicant believes that the "die" of the present invention corresponds to the MEMS "circuit chip" of Mortenson et al.

Note, with reference to Figs. 2 and 3 of the present invention, a tooling fixture **56** can be attached to the rear surface **55** of the die **24**. In one embodiment, the rear surface **55** is attached to the tooling fixture prior to the individual die being cut from the wafer (see page 9, line 31 – page 10, line 6). Once the tooling fixture is attached, the front surface or die reference surface is unobstructed and available for HF etching (see page 10, lines 10-12). Also note, with reference to Figs. 9 and 10, V-grooves **208** are formed in MEMS die **210**. The V-grooves **208** in the die **210** can be machined or formed using the MUMP's process (see page 14, lines 12-15). These descriptions of the "die" in the present application are consistent with Applicant's assertion that the "die" of the present application corresponds to the MEMS circuit chip of Mortenson et al.

The Patent Office asserts that Mortenson et al. teach a package frame (what Mortenson et al. call a fiber support device) having an aperture and a package frame reference surface adapted to receive the die reference surface. However, in Mortenson et al. the fiber support device surface is adapted to receive the platform, not the die (MEMS chip) (see, e.g., Figs. 1 and 5; and paragraphs [0013], [0015], [0018], and [0021]). Thus, Mortenson et al. do not teach or suggest the package frame of the present invention comprising an aperture and a package frame reference surface proximate the aperture adapted to receive a die reference surface such that the optical micro-mechanical devices are located in the aperture.

Also, the present invention is directed to a packaged optical micro-mechanical device comprising one or more optical interconnect alignment mechanisms. Distal ends of one or more optical interconnects are located in the optical interconnect alignment mechanisms and are optically coupled with one or more of the optical micro-mechanical devices (see page 2, lines 20-32; and

amended claim 1). The optical interconnect alignment mechanisms are adapted to align the optical interconnects with the optical micro-mechanical devices (see, e.g., page 8, line 30 – page 9, line 14; page 13, lines 5-17; and page 14, lines 8-29).

Mortenson et al. teach an optical component package including a platform, a fiber support structure, a circuit chip, and plurality of fibers (see paragraph [0004]). A semiconductor device, preferably a MEMS chip, is placed on the platform (see paragraph [0019]). Fibers are positioned on the MEMS chip, which has channels formed therein to house the fibers (see paragraph [0019]). The fibers extend through passages in the fiber support structure (see paragraph [0019]). Mortenson et al. further teach that the fiber support device protects the chip and its wire bonds during assembly and provides additional structure by the passages to capture and hold the fiber. This greatly simplifies assembly since once the fibers are properly positioned they are maintained in their proper position (see paragraph [0020], emphasis added).

Thus, nothing in Mortenson et al. teaches or suggests the optical interconnect alignment mechanisms of the present invention.

For at least these reasons, the rejection of claim 1 under 35 USC § 102(e) as being anticipated by U.S. Patent Application Publication No. 2002/0097951 (Mortenson et al.) has been overcome and should be withdrawn.

Claims 2-4, 7-10, 12, 28-30, 32, and 37 each add additional features to claim 1. Claim 1 is patentable over Mortenson et al. for the reasons given above. Thus, claims 2-4, 7-10, 12, 28-30, 32, and 37 are likewise patentable over Mortenson et al.

Claims 1, 11, 12, 15, and 27 stand rejected under 35 USC § 102(b) as being anticipated by "Free-Space Fiber-Optic Switches Based on MEMS Vertical Torsion Mirrors," (Lee et al.).

In the present invention, a first surface of the package frame comprises both a package frame reference surface and one or more optical interconnect alignment mechanisms (see, e.g., Figs. 1 and 6; page 2, lines 23-28; and amended claim 1). The package frame reference surface is adapted to allow the die reference surface to be mounted to the package frame reference surface (see, e.g., Figs. 1-3; page 7, lines 5-6; page 8, lines 14-16; and amended claim 1). As used in the present application, "die" refers to a substrate containing one or more optical micromechanical devices (see page 7, lines 7-9) and "die reference surface" refers to the top surface of the die upon which the optical micromechanical devices are constructed (see page 8, lines 23-24).

Lee et al. disclose a fiber optic switch and silicon submount. The submount consists of a bottom wafer, a top wafer, and a mirror or switch chip. The top wafer has a central opening whose area matches that of the chip. The bottom wafer is bonded to the lower surface of the top wafer, while V-grooves are formed in the top surface of the top wafer. The chip, comprising four surface-micromachined vertical torsion mirror devices, is positioned in a recess formed in the bottom wafer and extends into the central opening in the top wafer (see Fig. 11; and pages 10-11).

Lee et al. teach that the top and bottom wafer are aligned by inserting dummy optical fibers into matching V-grooves etched on their respective bonding surfaces. After bonding the wafers together, the chip is placed in the center opening (see page 11 "Assembly"). Finally, ball lenses and optical fibers are placed in micropits and V-grooves, respectively, formed in the top surface of the top wafer (see Fig. 9, and page 11 "Assembly").

Thus, Lee et al., neither teach nor suggest bonding the die reference surface (i.e., the top surface of the die upon which the optical micromechanical devices are constructed) to the package frame reference surface.

For at least this reason, the rejection of claim 1 under 35 USC § 102(b) as being anticipated by "Free-Space Fiber-Optic Switches Based on MEMS Vertical Torsion Mirrors," (Lee et al.) has been overcome and should be withdrawn.

Claims 11, 12, 15, and 27 each add additional features to claim 1. Claim 1 is patentable over Lee et al. for the reasons given above. Thus, claims 11, 12, 15, and 27 are likewise patentable over Lee et al.

§ 103 Rejections

Claims 5, 6, 13, 14, 21, and 22 stand rejected under 35 USC § 103(a) as being unpatentable over Mortenson et al.

Claims 5, 6, 13, 14, 21, and 22 each add additional features to amended claim 1. Applicant believes that the amendment to claim 1 renders the rejection of claims 5, 6, 13, 14, 21, and 22 under § 103(a) as moot for the reasons stated above.

In summary, the Applicant respectfully requests that the rejection of claims 5, 6, 13, 14, 21, and 22 under 35 USC § 103(a) as being unpatentable over Mortenson et al. be withdrawn.

Corrections to the Drawings

Applicant respectfully requests that the following corrections to the drawings be allowed.

Figure 1 has been amended as follows:

The line format of the die (**24**) has been changed to "phantom." Support for this amendment is found on page 7, lines 6-7.

Figure 2 has been amended as follows:

The cross-hatching of the package frame (**20**) has been changed to indicate an insulative part. Support for this amendment is found at page 7, line 24 - page 8, line 12.

The cross-hatching has been removed from the aperture (**22**). Support for this amendment is found at page 10, lines 20-25.

The line format for optical micro-mechanical devices (**43**) has been changed to "phantom." Support for this amendment is found at page 8, lines 20-21.

The cross-hatching for the flex circuit (**60**) has been changed to indicate a conductive material. Support for this amendment is found at page 9, lines 15-21.

The cross-hatching has been removed from the lenses (**70**) shown in end-view. Support for this amendment is found at page 2, lines 27-31.

Figure 3 has been amended as follows:

The cross-hatching of the package frame (**20**) has been changed to indicate an insulative part. Support for this amendment is found at page 7, line 24 - page 8, line 12.

The cross-hatching has been removed from the aperture (**22**). Support for this amendment is found at page 10, lines 20-25.

The line format for optical micro-mechanical devices (**43**) has been changed to "phantom." Support for this amendment is found at page 8, lines 20-21.

The cross-hatching for the flex circuit (**60**) has been changed to indicate a conductive material. Support for this amendment is found at page 9, lines 15-21.

The cross-hatching has been removed from the lenses (**70**) shown in end-view. Support for this amendment is found at page 2, lines 27-31.

Figure 4 has been amended as follows:

The cross-hatching of the package frame has been changed to indicate an insulative part. Support for this amendment is found at page 7, line 24 - page 8, line 12.

The cross-hatching has been removed from the aperture. Support for this amendment is found at page 10, lines 20-25.

The line format for optical micro-mechanical devices (**43**) has been changed to "phantom." Support for this amendment is found at page 8, lines 20-21.

The cross-hatching has been removed from the lenses shown in end-view. Support for this amendment is found at page 2, lines 27-31.

Figure 5 has been amended as follows:

The cross-hatching of the package frame (**86**) has been changed to indicate an insulative part. Support for this amendment is found at page 7, line 24 - page 8, line 12.

The cross-hatching has been removed from the aperture. Support for this amendment is found at page 10, lines 20-25.

The line format for optical micro-mechanical devices has been changed to "phantom." Support for this amendment is found at page 8, lines 20-21.

The cross-hatching for the flex circuit (**92**) has been changed to indicate a conductive material. Support for this amendment is found at page 11, lines 30-32.

The cross-hatching has been removed from the lenses shown in end-view. Support for this amendment is found at page 2, lines 27-31.

Figure 6 has been amended as follows:

The line format for the die (**104**) has been changed to "phantom." Support for this amendment is found at page 12, lines 28-29.

Figure 7 has been amended as follows:

The cross-hatching of the package frame (**100**) has been changed to indicate an insulative part. Support for this amendment is found at page 7, line 24 - page 8, line 12.

The cross-hatching has been removed from the aperture (**102**). Support for this amendment is found at page 10, lines 20-25.

The cross-hatching for the flex circuit (**136**) has been changed to indicate a conductive material. Support for this amendment is found at page 13, lines 22-29.

The cross-hatching has been removed from the lenses (**126**) shown in end-view. Support for this amendment is found at page 2, lines 27-31.

Figure 8 has been amended as follows:

The cross-hatching of the package frame (**100**) has been changed to indicate an insulative part. Support for this amendment is found at page 7, line 24 - page 8, line 12.

The cross-hatching has been removed from the aperture. Support for this amendment is found at page 10, lines 20-25.

The cross-hatching for the flex circuit (**158**) has been changed to indicate a conductive material. Support for this amendment is found at page 14, lines 1-3.

The cross-hatching has been removed from the lenses shown in end-view. Support for this amendment is found at page 2, lines 27-31.

Figure 10 has been amended as follows:

The cross-hatching of the package frame (**216**) has been changed to indicate an insulative part. Support for this amendment is found at page 7, line 24 - page 8, line 12.

The cross-hatching has been removed from the aperture. Support for this amendment is found at page 10, lines 20-25.

The cross-hatching for the flex circuit has been changed to indicate a conductive material. Support for this amendment is found at, e.g., page 14, lines 1-3.

The line format for optical micro-mechanical devices (**224**) has been changed to "phantom." Support for this amendment is found at page 8, lines 20-21.

The cross-hatching has been removed from the lenses (**230**) shown in end-view. Support for this amendment is found at page 2, lines 27-31.

Figure 12 has been amended as follows:

The cross-hatching of the package frame (**314**) has been changed to indicate an insulative part. Support for this amendment is found at page 7, line 24 - page 8, line 12.

The cross-hatching has been removed from the aperture (**312**). Support for this amendment is found at page 10, lines 20-25.

The line format for optical micro-mechanical devices (**310**) has been changed to "phantom." Support for this amendment is found at page 8, lines 20-21.

The cross-hatching for the flex circuit (**318**) has been changed to indicate a conductive material. Support for this amendment is found at page 15, lines 15-18.

The cross-hatching has been removed from the lenses (**306**) shown in end-view. Support for this amendment is found at page 2, lines 27-31.

Applicant submits no new matter has been entered.

In view of the above, it is submitted that the application is in condition for allowance. Reconsideration of the application is requested.

Allowance of claims 1-37, as amended, at an early date is solicited.

Respectfully submitted,

10 February 2003
Date

By: _____
Scott A. Bardell, Reg. No.: 39,594
Telephone No.: 651-736-6935

Office of Intellectual Property Counsel
3M Innovative Properties Company
Facsimile No.: 651-736-3833

Version with markings to show amendments made:

1. (Amended) A package for optical micro-mechanical devices, comprising:

[a die comprising] one or more optical micro-mechanical devices on a first surface of a **die** **[substrate]**, the first surface **of the die** including a die reference surface;

a package frame comprising an aperture and a **first surface, the first surface of the package frame comprising a** package frame reference surface proximate the aperture**, wherein the package frame reference surface is** adapted to **allow** **[receive]** the die reference surface **to be mounted to the package frame reference surface** such that the optical micro-mechanical devices are located in the aperture;

one or more optical interconnect alignment mechanisms **formed in the first surface of the package frame,** terminating adjacent to the aperture **and** **[are]** positioned relative to an optical interface reference plane; and

distal ends of one or more optical interconnects located in the optical interconnect alignment mechanisms and optically coupled with one or more of the optical micro-mechanical devices.

12. (Amended) The apparatus of claim 1 wherein the optical interconnect comprises one of an optical fiber and **a lens** **[optical fiber]**.

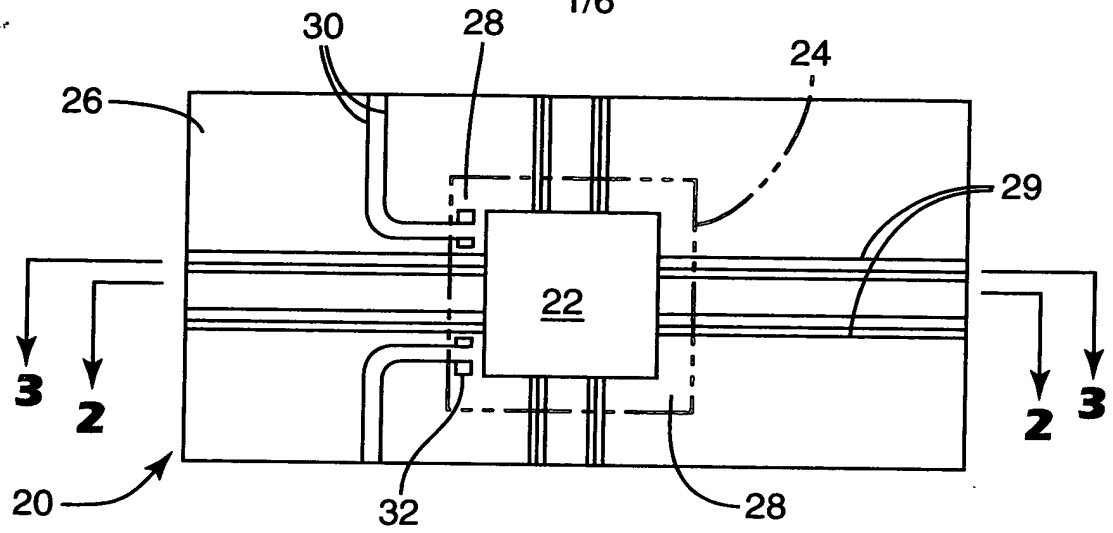

FIG. 1

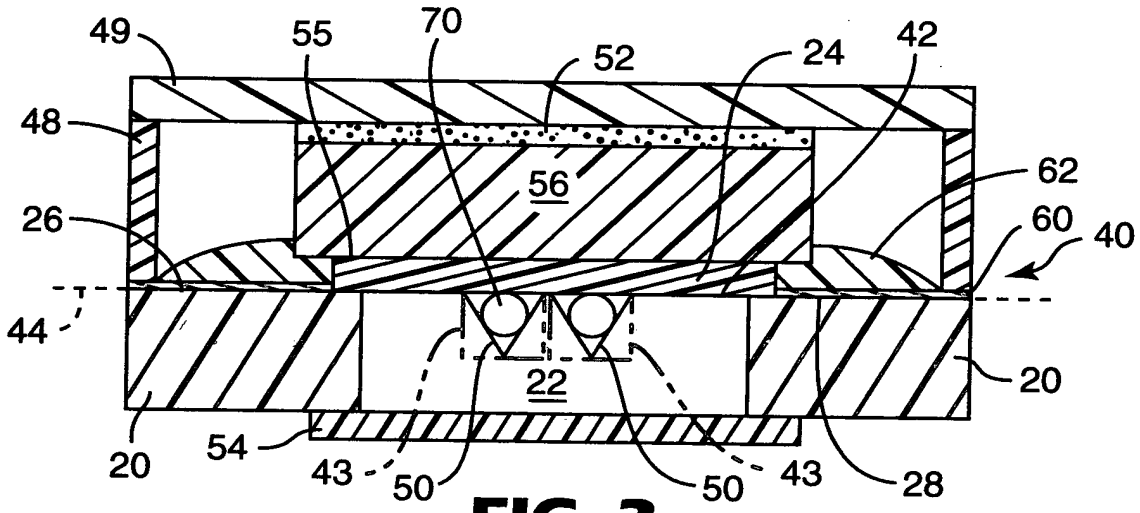

FIG. 2

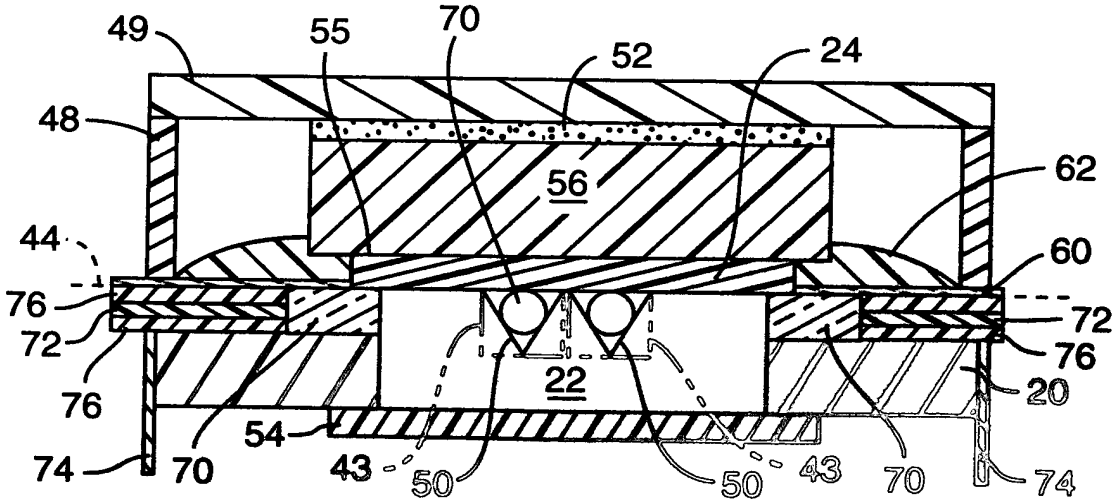

FIG. 3

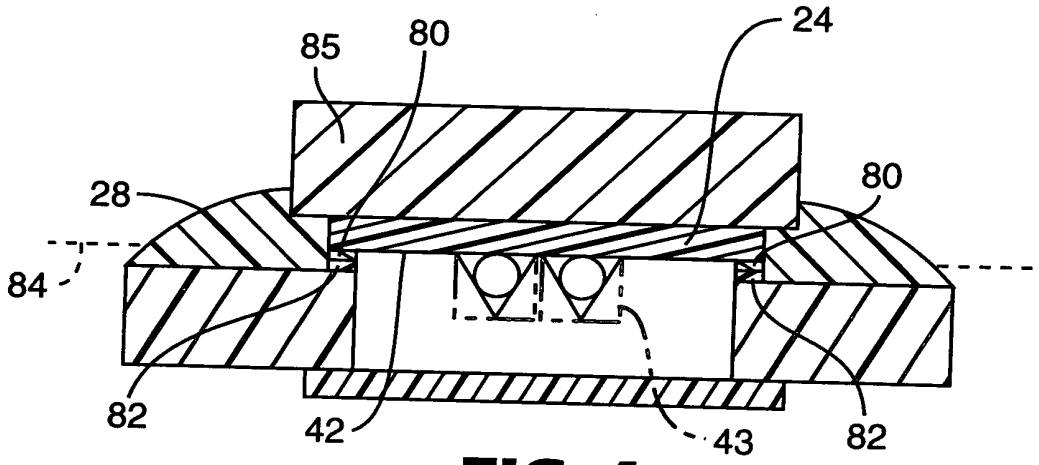

FIG. 4

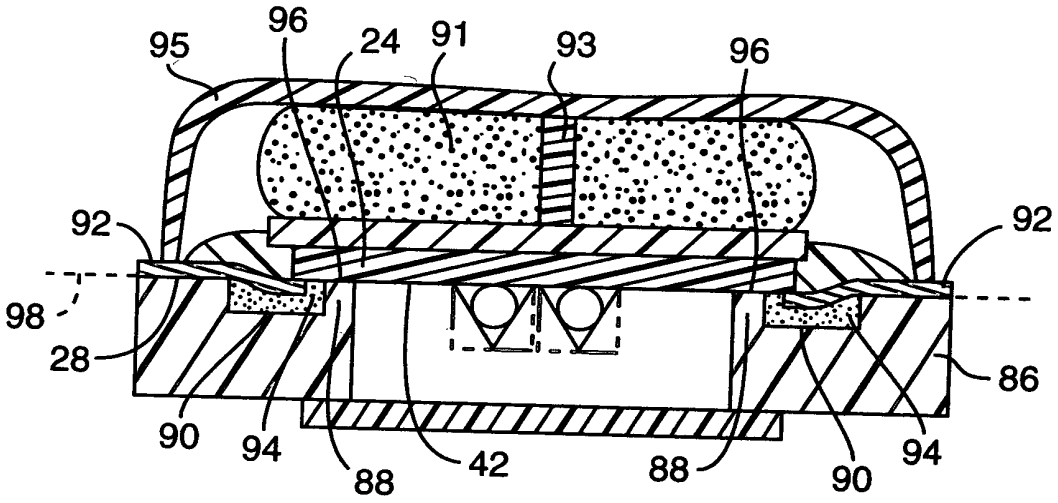

FIG. 5

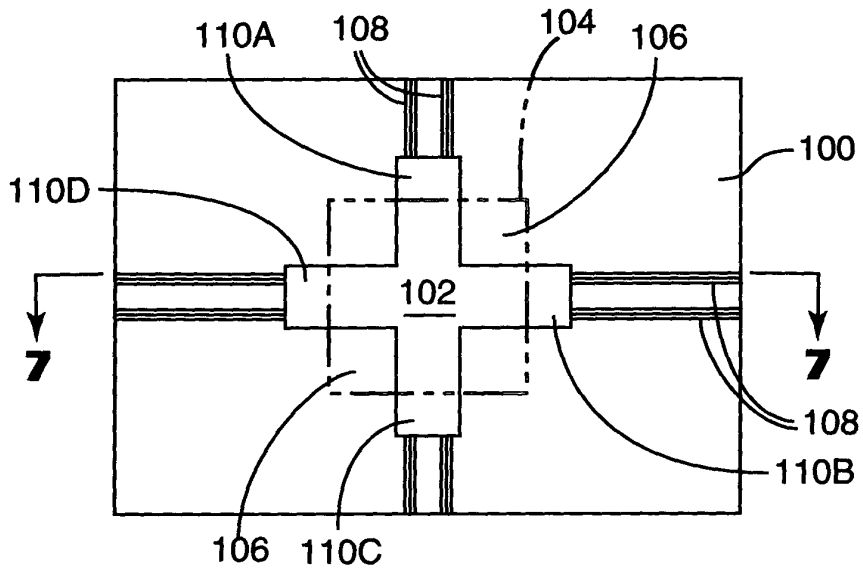

FIG. 6

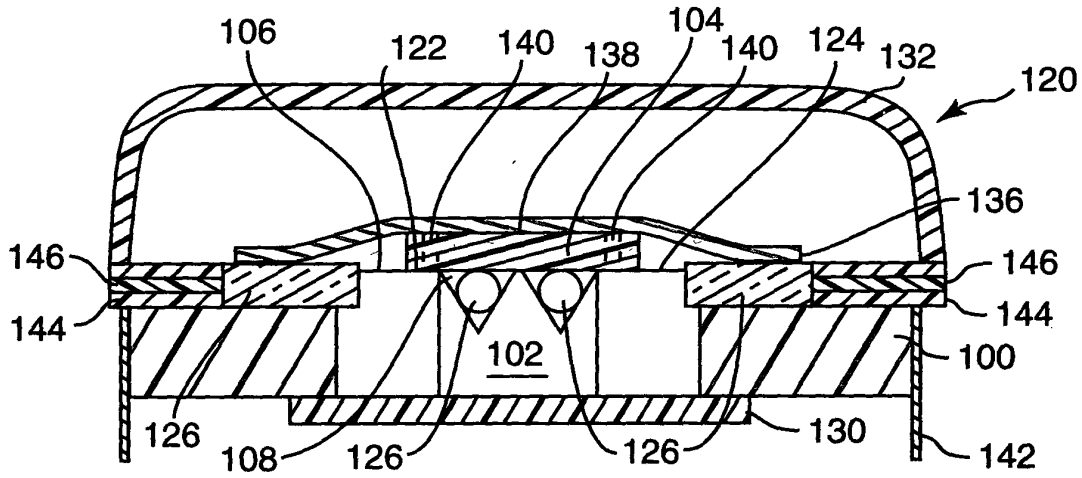

FIG. 7

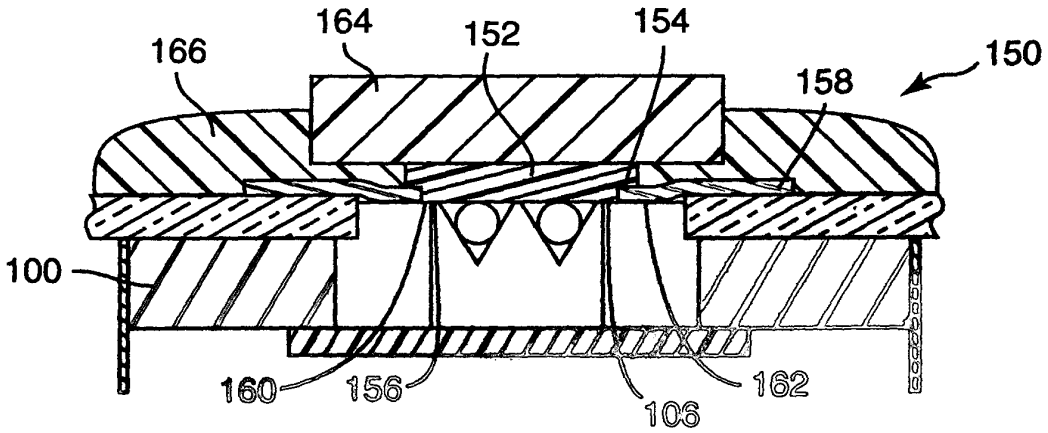

FIG. 8

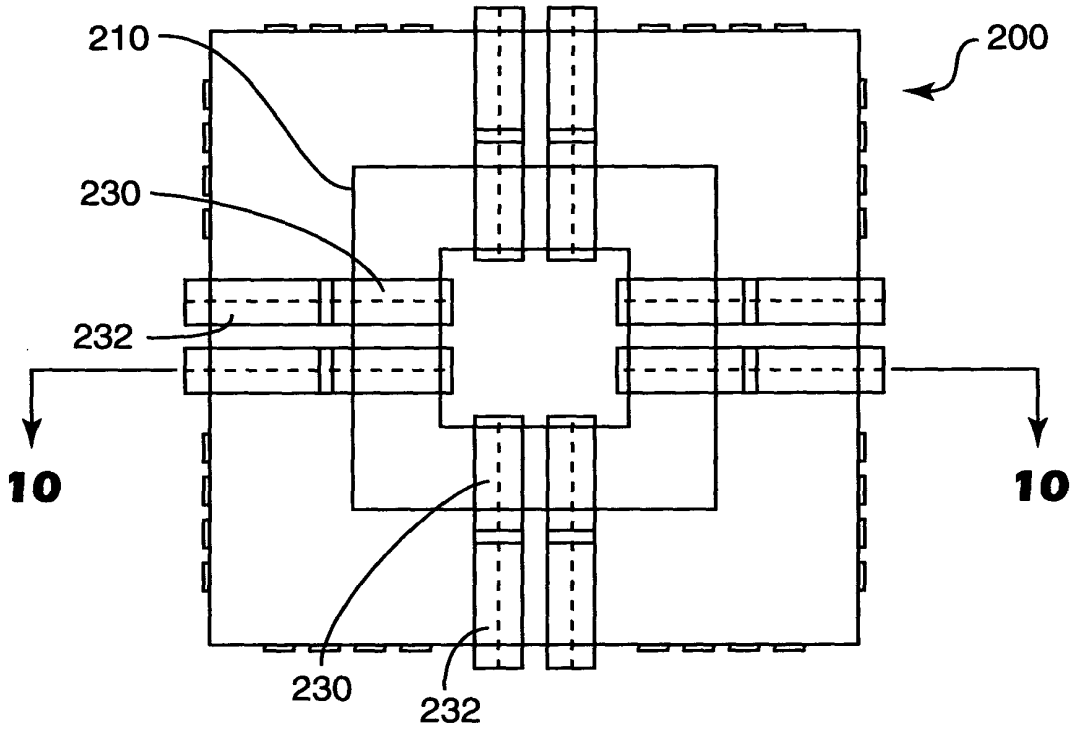

FIG. 9

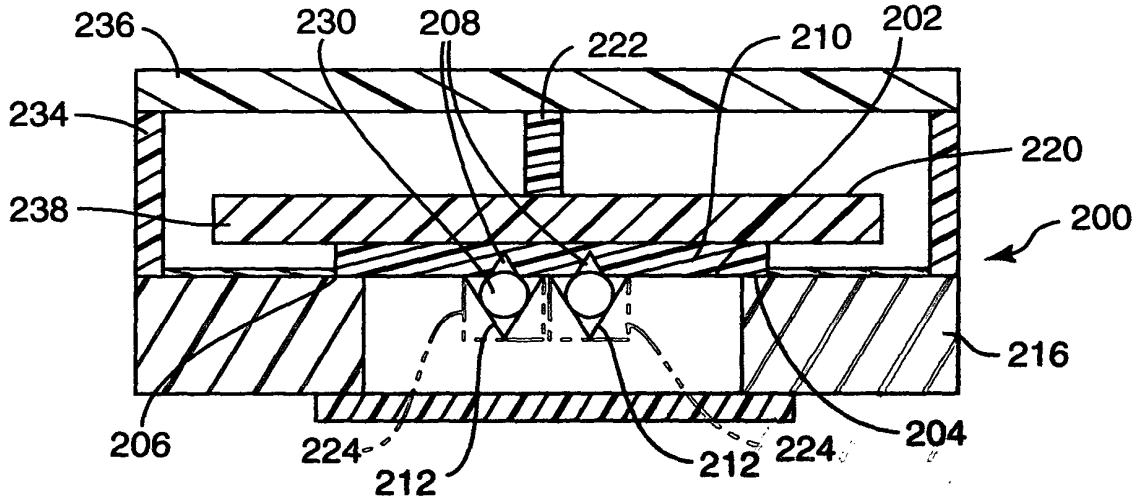

FIG. 10

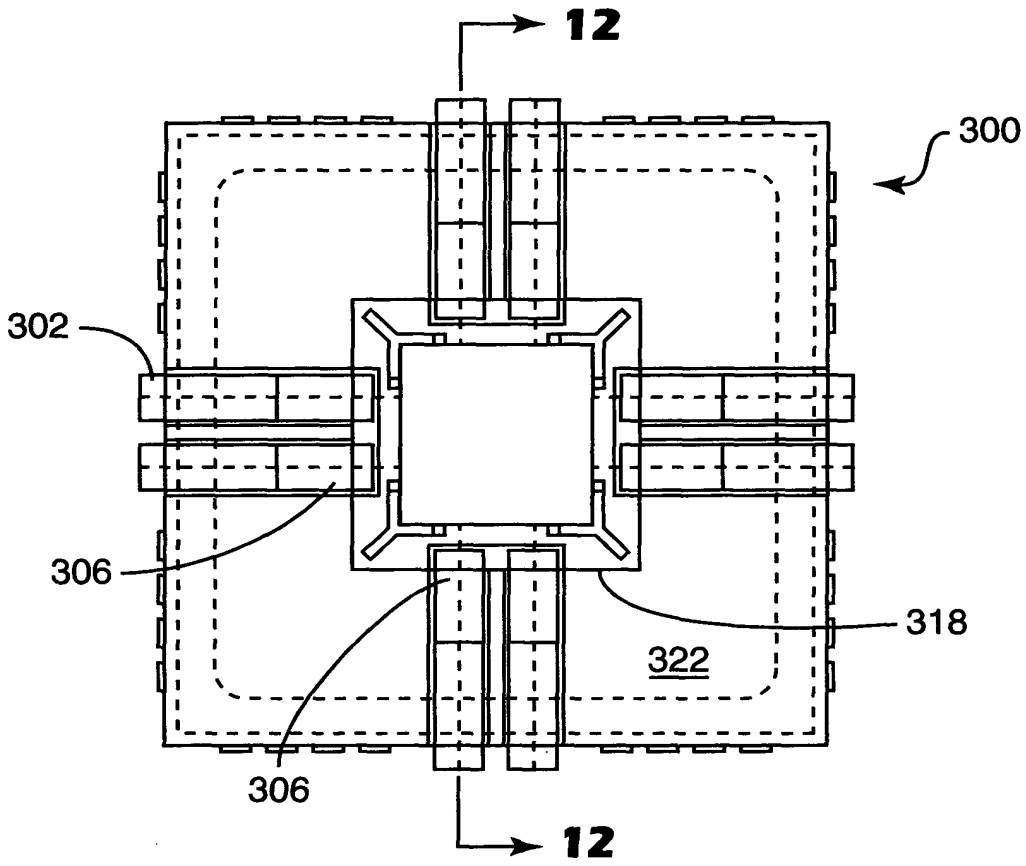

FIG. 11

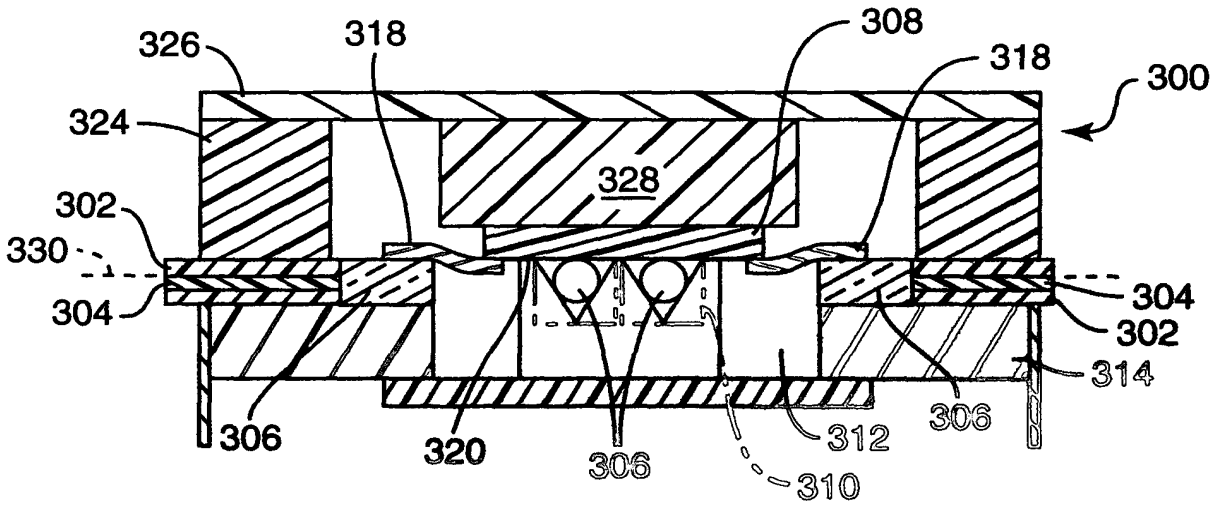

FIG. 12

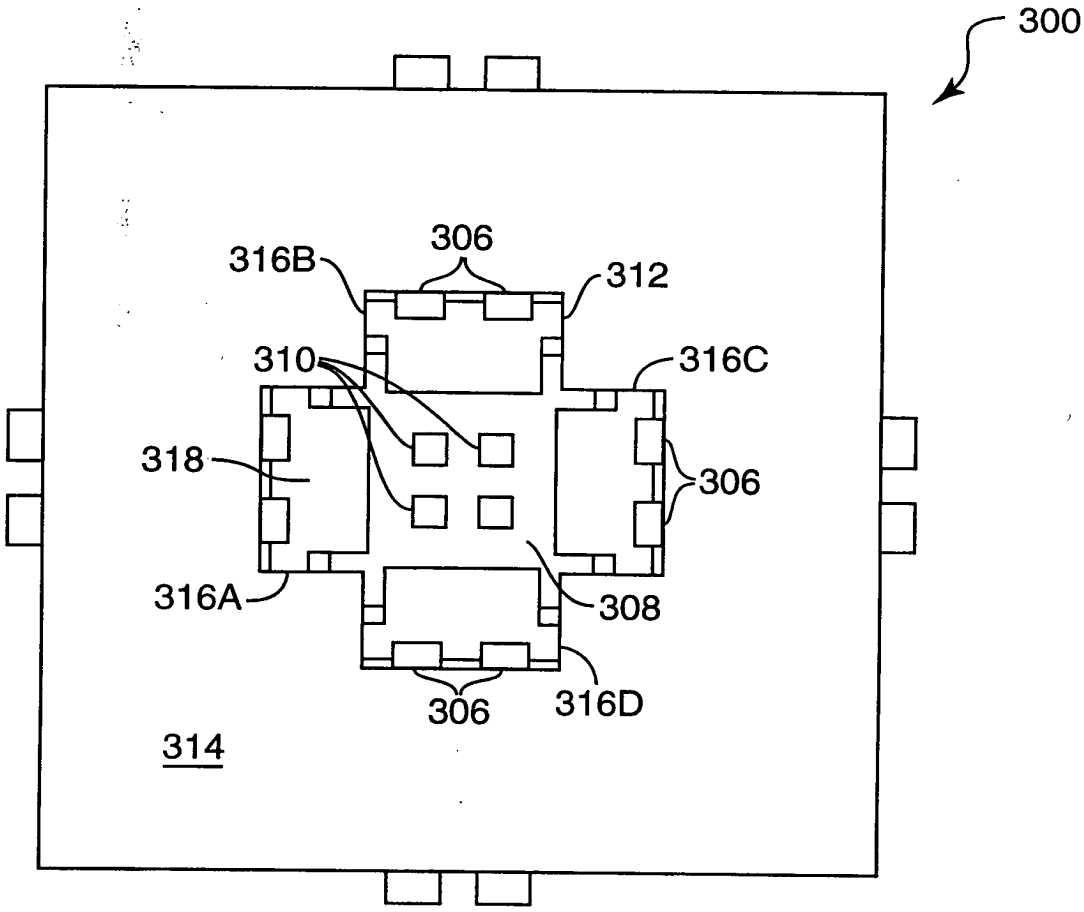

FIG. 13